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ABSTRACT

"Scientific ways of thinking and problem solving are deeply ingrained in how we think and act, day by day. Scientific approaches are used, often unknowingly, by most people." Most of us would agree with this statement which comes from the National Science Statement but it does not apply to Anangu and many other indigenous people. Anangu, who live in the far north west of South Australia and the adjoining areas in the NT and WA, base their lives on different beliefs, values and concepts from most non-Anangu. However, their elders have decided that the young must learn the "secrets of the white fella way" in order to achieve self-determination. What skills do these students need and how does science education support their acquisition? Is the same true for indigenous students in mainstream schools? These are questions this paper seeks to explore. (Author)

The importance of Science education for Indigenous students

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Introduction

"Scientific ways of thinking and problem-solving are deeply ingrained in how we think and act, day by day. Scientific approaches are used, often unknowingly, by most people. It is almost part of our nature to want to expand our understanding of the world, to have a healthy intellectual scepticism, to search for solutions for problems. We continually look for reasons for why things are so and seek rational explanations of how things work. The processes, attitudes and values of science are powerful generators of knowledge for us all" (Science Statement, p.4).

This may apply to many of us who have a background in the Western world, but it does not apply to Anangu and many other indigenous cultures in Australia and other parts of the world.

Cause and effect

Despite their lack of background in the Western way of thinking, Anangu have accepted many of the scientific and technological advances that are part of our lives today. They have eagerly accepted and are comfortable with such technologies as the telephone, TV, video, radio, cars, trucks, planes, trains..... And children at school take to the computer very quickly. Through experience some are learning about caring for these so that the machines continue to function.

However, most are better at learning how to fix things than they are at preventing abuse of them and they are gullible because they lack "basic scientific knowledge and / or an understanding of evidence to make sense of information offered" (Feasey 1998:32). The following two examples illustrate this in different specific contexts.

The motor vehicle

Because Anangu are now more sedentary than they were before 'whitefella' contact and most of them now live in reasonable sized communities many kilometres away from each other, they are now dependent on motor vehicles to get from one place to another. They understand that the vehicles need fuel and wheels with pumped up tyres in order to make them go. Some also understand the need for water in the radiator and oil in the engine but, for most, that is as far as it goes. Almost all lack the concept of regular maintenance in order to keep the vehicle going and the need to carry spares when they travel. Provided the vehicle goes, they have some fuel and the tyres look OK they will head off on long trips in what we would consider unsafe vehicles. This is why they than can often be duped into paying exorbitant prices for unroadworthy vehicles.

There is no concept of caring for the vehicle. One often sees an overloaded vehicle running on half its cylinders setting out on a 200km journey. Provided it gets them there they are happy, regardless of what further damage might be done to the vehicle. Sometimes vehicles, usually four wheel drive vehicles, are taken off the road in pursuit of kangaroos or emus. They follow the animal as far as they can, regardless of the terrain. Therefore, there are many deserted vehicles in most unlikely places because axles, etc. have been broken.

Also, Anangu rarely plan or prepare for the inevitable vehicle breakdowns. This is why, when travelling on the dirt roads between communities, one sees many vehicles abandoned where they stopped. If the breakdown has been caused by a simple matter such as running out of fuel or a puncture they will simply wait for someone to come along to help them out. Fuel supplies are often shared but when it comes to needing to change a wheel they usually take off the damaged wheel and get a lift to the nearest broken down vehicle or community to get a replacement. They are adept at fixing up vehicles to keep them going and using wrecks as banks for spare parts. Keys are a nuisance so most vehicles are usually started by crossing wires. This means anyone can use them! It's all a matter of priorities.

Health

The same applies to their own health. Anangu appreciate how modern knowledge about diseases and medications can help in their treatment. However, the vast majority still have little understanding of the role bacteria, viruses and parasites play in causing many diseases and how simple matters such as cleanliness and a healthy diet can prevent the occurrence and spread of many diseases. As a result, hygiene and healthy lifestyles are low on their priorities of life and many, if not most, of the children suffer from media otitis, scabies, dietary deficiencies and bad teeth. Other common diseases include diabetes, ringworm, heart disease, trachoma, stress... There are a variety of reasons for the prevalence of such diseases.

Anangu naturally have good sight but flies and dust are a normal part of life in the centre of Australia. Trachoma, left untreated, can lead to blindness whereas it can be prevented by a simple regime of regularly washing hands and faces.

Large groups of people (often 20 – 25) sharing the same house makes cleanliness difficult to maintain. Several share the same bed and bedding. Feeding the multitudes is more a priority than washing bedding. And dogs are part of the family group, often sleeping in very close proximity to young and old, particularly in the winter. As a result, scabies and ringworm are rife. Untreated, scabies can become infected and lead to rheumatic heart disease.

Anangu have a very sweet tooth. For example, most nonAnangu find honey ants far too sweet whereas Anangu indulge whenever they can. Therefore, it is not hard to understand why that, since they were introduced to sugar, it has become a large part of their diet. The kids eat a lot of sweets and drink a lot of sweetened drinks. As a result, both adults and children and adults have bad teeth and many develop diabetes. In addition, they have retained their preference for fatty meat such as kangaroo tails even though they no longer have to use up the same amount of energy to obtain this delicacy as they used to. This increases their risk of heart disease.

As a result of the high incidence of disease among all members of the community, particularly the young, Anangu consider themselves 'old' at thirty and expect to die soon after they reach 'fifty', if they live that long.

Convincing Anangu to change their habits and life styles to improve their health and longevity is not easy. The local stores do not help. The stores have to run at a profit. The cheapest items of food are the least healthy and in greater supply than the more healthy fruit and vegetables. For example, white flour & sugar are much cheaper than fruit & vegetables. This is partly because the stores only receive their stocks once a week or even once a fortnight and they have limited storage space for perishables. Once the fresh food is gone all have to wait for the next truck. In the meantime, there is still plenty of the less healthy food that keeps better and families buy it because they have to eat.

Planning for the future

The two examples above illustrate how poorly most Anangu plan for the future in today's world terms. Traditionally, the concept of saving for the future was a meaningless concept. Anangu had no means of preserving food and, in any case, because they were constantly on the move there was a limit to what they could carry. Therefore, they carried the essentials such as grinding stones and tools for catching game and making fire. Everything else they got from their environment. When food was available they would eat to their fill and when it was scarce they would go hungry. Rubbish disposal was not a problem as they were continually on the move. As all of it was natural, it would decompose before they returned.

However, this does not mean traditional Anangu did not plan for the future. In fact, doing so was essential for their survival. For example, in common with other groups of indigenous people, they always left some fruit on trees even if they were hungry because they knew that the survival of the species depended on the seeds the fruit contained. Also, when the time was right they set fire to grasses so that these would regenerate and there would be a good crop when they came by the following year. Similarly, they cleaned waterholes regularly and covered them to prevent animals fouling them.

The lifestyle Anangu live today reflects a lack of planning for the future (as distinct from being future oriented) simply because their traditional ways of living do not fit well with the current environments in which they live. Change in circumstances, imposed by the Western world, has come too fast for Anangu to change their attitudes to life.

Bringing about change

There is no easy solution to this because unless change is driven by Anangu it will not last and Anangu will become more dependent than they are at the moment. For example, because the stores are controlled by AP (Anangu Pitjantjatjara) Council, the priority of the stores could change. However, Anangu would need to:

- recognise the need for the stores to change

- convince either the store managers or AWS to change store policy so that there was not so much emphasis on making a profit
- lobby and put pressure on the appropriate bodies to bring about the change
- change their buying habits and priorities
- accept that the stores will not make so much of a profit and will not then be able to buy things for the communities.

All these things are related to Self Determination.

What is Self Determination and how do Anangu conceptualise Self Determination?

- Self determination means that Anangu decide what they want and take the steps needed to get there.
- The vision of Anangu for their communities has been conceptualised in a dot painting.

What does Self Determination mean in practice in Anangu Schools?

- This means students need to gain and understand how to use knowledge, skills and processes most nonAnangu take for granted. Only then will they have power over:
  - decision making – individual and group
  - relationships – with nonAnangu and Anangu
  - resources
  - information.
- Students can and should learn these skills through all curriculum areas.
- Teachers and Anangu Education Workers (AEWs) must be explicit about nonAnangu values, concepts and ways of doing things without inferring that either the Anangu or nonAnangu (Western) way is better than the other.
- Teachers and AEWs must assist students to develop the necessary skills in both Anangu and nonAnangu contexts.
- In order to empower Anangu, nonAnangu staff must consciously work towards diminishing their own power and influence. Therefore, they need to continuously challenge their own thinking and practices.

How is this a special problem? Won't a mainstream education provide this?

- Anangu and nonAnangu base their lives on different beliefs, values and concepts. These sometimes seem to be confusing or even opposing. Some examples are:
  - Time (management, schedules, planning, appointments)
  - Money (wealth, poverty, saving, budgeting, ownership)
  - Work (role definitions, line management, supervision and appraisal)
  - Family (dependents, responsibilities, gender, extent)
  - Manners (greetings, voice tone and volume, making requests)
  - Recreation (special events, games, toys)
  - Spirituality (ceremonies, practices, facilities, access)
  - Education (qualifications)

Why, then, is Science so important for Anangu students?

Almost every Science lesson will naturally involve students in practising the 'four powers'.

1. Decision making
2. Relationships
3. Resources
4. Information

In all cases these experiences can be either made Anangu friendly or the nonAnangu teacher can explicitly teach the nonAnangu way and the reasons for this can be discussed. In the process Anangu students learn a lot about Western society that nonAnangu take for granted.

1. Decision Making

- discussing options
- making choices of what to do, how to do it and who will be involved
- supporting Anangu-way decision making processes where appropriate
- deciding about with whom to share information and how to do this
- deciding how work can best be assessed.

2. Relationships

A. Communicating effectively

- making predictions
- stating opinions
- listening to the opinions of others
- presenting reports to small groups or the class.

B. Working collaboratively

- working in small groups and teams
- negotiating tasks
- sharing resources
- sharing information
- helping others use resources.

C. Behaving responsibly and respectfully

- taking turns using resources
- making others feel safe when they make predictions or express opinions
- making choices that consider the needs of others
- demonstrating an awareness of the rights and responsibilities of others
- responding appropriately to peer pressure
- responding appropriately to the opinions of others.

3. Resources

- identifying equipment and resources relevant to solving the problem
- locating and accessing these resources
- solving problems using these resources
- using equipment responsibly
- learning how to look after and store special equipment
- understanding the responsibility of ownership and borrowing

- listening to Aboriginal information on the topic from those who know.

4. Information

A. Accessing information

- talking about information they already know
- asking questions to find out specific information
- comparing information found with that found by others
- using technology to gather information.

B. Analysing information

- distinguishing between fact and opinion
- sorting out what is relevant to the problem
- analysing specialist language and jargon
- thinking about what others will want to know or be interested in
- comparing ways different information has been gained
- relating the ways information has been obtained to its purpose
- summarising information.

C. Presenting information

- presenting information in different ways for different audiences
- using different techniques to illustrate what the information shows
- using a variety of technology and media.

D. Examining bias

- using discussion, reporting and argument genres to debate issues
- assessing the credibility of various opinions
- examining relevant Aboriginal information.

Dealing with information and the language of Science

Another reason why it is difficult for Anangu to change their eating and living habits is because they do not understand how to deal with the statistics provided in information related to health and education. They are also gullible to advertising because they do not have the skills to see through it. According to Feasey (1998: 31):

> "Education...has a key role to play in changing attitudes and developing future generations that are scientifically literate...if the prerequisites for a scientifically person are clearly identified and translated into the school curriculum."

Feasey (1998: 32) identifies four elements of the scientifically literate person:

1. Factual background – an understanding of key ideas and facts and an ability to apply such concepts in a range of contexts.
2. Understanding of evidence – an understanding of why it is collected and an ability to challenge the reliability and validity of such evidence.
3. A questioning attitude – a healthy scepticism and willingness to challenge science and the evidence it offers.
4. Communicative ability – an understanding of and ability to communicate in science.

These kinds of knowledge are highly valued in the Science curriculum and "those students who can access this privileged knowledge are more likely to experience success during their formal schooling" (Torr and Harman 1997: 223). As the following discussion shows, many indigenous students, particularly those like Anangu for whom English is a second language and culture, start from a different world view that makes learning Science more difficult.

Anangu have a good understanding of the natural world around them. However, this understanding has been developed in a variety of ways, many of which would not often be seen as being scientifically based. For example, the origin of the natural environment in which they live and how to care for the land are recorded in 'dreaming stories' passed on largely orally since time immemorial. The concepts of 'facts', 'theories' and 'evidence' have no place in this knowledge of the world.

Kirkwood (1998: 76) explains why language in Science can be a source of considerable confusion for learners. There are lots of terms, like battery and cell, used in everyday life that have different names in a science context. Sometimes the same word has another very different meaning in another field of science too. For example, cell has another very different meaning in biology where it refers to the building blocks of living things. This is quite different to being a source of electricity, which is the meaning of cell in physics. Even more confusing is the use of the same word which has one meaning in everyday language and quite a different one in a science context, for example: 'work', 'force', 'power'. We would add that such use of language is even more complex for children when English is their second language as it is for all Anangu and many other indigenous students.

The cultural use of different forms of language can also pose problems for indigenous students such as Anangu. For example, young Anangu children are expected to learn by observing and copying. They are not expected to ask questions of their elders. Therefore, it is more difficult to encourage such students to ask questions at school, one of the main ways Science education uses for engaging students in learning about their world (see Feasey 1998: 56) and Appendix I).

In addition, there are the grammatical metaphors that are a considerable feature in the construction of scientific and technical knowledge (Torr and Harman 1997: 222). The most common grammatical metaphors involve 'nominalization' (Halliday 1994: 352) where events are interpreted by verbs and entities by nouns (Torr and Harman 1997: 225). For example, in Science we study 'movement' rather than objects moving.

How we can address these issues in Science

In one sense Science educators of Anangu and other speakers of languages other than English have to present ideas as simply as possible, using many of the strategies that are used for younger learners of Science. For example, we could demetaphorise our conversations, just as most adults do when talking with young children, and use the active rather than the passive forms of verbs. However, it is important to remember the age and interests of the science learners and their future Science learning. The context of the learning experiences cannot be 'childish' if we are working with adolescents and there are certain forms of language that students of Science need to understand regardless of their abilities to communicate in and understand English.

The only way to address this anomaly is to explicitly teach questioning skills and the language and grammar of Science in an appropriate contexts. Therefore, every Science lesson also becomes a lesson in literacy and Science teachers also become teachers of English. If Science teachers view responsibility for such literacy practices as resting with the English teacher they will put minimal writing and reading demands on their students in the Science context (Green 1998) and deny indigenous students future success in Science studies and access to skills for Self Determination.

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Appendix I

Teachers and Students as Effective Questioners in Science

Adapted from Feasey (1998: 56)

The teacher as effective questioner	The student as effective questioner
The teacher questions students to find out prior knowledge and understanding.	Students ask questions relating to what they know and what they want to know.
The teacher asks questions to scaffold students' learning.	Students decide how they could answer their questions (e.g. book, look, investigate).
The teacher supports students in investigations through offering questions to help them plan their investigation	Students ask questions to support their planning for learning and how to carry out investigations.
The teacher challenges students to use 'science spectacles' to make sense of phenomena or data from surveys and investigations through making connections with science understanding.	Students ask questions to challenge each other to explain what they did and why, to interrogate data, to question believability and explain their conclusions.
The teacher asks students questions in feedback sessions for informal and formal assessment of learning.	Students ask questions of their own learning. 'What have I learnt?' 'What do I know that I did not know before?' 'What else do I need to know?'

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